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V.—FORMULAS FOR STRENGTH OF FLAT PLATES

Rectangular Flat Plates, Supported at all Four Edges and Loaded with a Center Load W.

Author and Reference	Formula as Given by Author	Safe Load at Center of Plate $W=$	Unit Stress in Extreme Fiber of Material $f=$	Thickness of Plate in Inches $t=$
Grashof, Trautwines C. E. Pocket Book, Page 493	$f=\frac{3CWLl}{2t^2(L^2+l^2)}$ $C=2.$	$0.34\frac{ft^2(L^2+l^2)}{Ll}$	$3\frac{WLl}{t^2(L^2+l^2)}$	$1.73\sqrt{\frac{WLl}{f(L^2+l^2)}}$
Rankine, Civil Engineering, Page 543	$M=\frac{3WL^4l}{8(L^4+l^4)}$ Where L is less than 1.19 l	$0.45\frac{ft^2(L^4+l^4)}{L^3l}$	$2.25\frac{WL^3l}{t^2(L^4+l^4)}$	$1.5\sqrt{\frac{WL^3l}{f(L^4+l^4)}}$
Rankine, Civil Engineering, Page 543	$M=\frac{Wl}{4}$ being the same as for a plate supported at side edges only	$0.67\frac{fLt^2}{l}$	$1.5\frac{Wl}{Lt^2}$	$1.225\sqrt{\frac{Wl}{fL}}$
Rectangular Flat Plates, Firmly Secured along all Four Edges and Loaded with a Center Load W.				
Grashof, Trautwines C. E. Pocket Book, Page 493	$f=\frac{3CWLl}{2t^2(L^2+l^2)}$ $C=1.75$	$0.38\frac{ft^2(L^2+l^2)}{Ll}$	$2.62\frac{WLl}{t^2(L^2+l^2)}$	$1.6\sqrt{\frac{WLl}{f(L^2+l^2)}}$

M = Maximum Bending Moment, Inch Pounds.
L = Long Span Between Supports.
l = Short Span Between Supports.
W, f, and t as given above

Note: Rankine gives Bending Moment M only as given in 2nd. line. Writer assumes Resisting Moment M_1 as $M_1=\frac{fLt^2}{6}$
Then $M=M_1$ or $\frac{3WL^4l}{8(L^4+l^4)}=\frac{fLt^2}{6}$ also $\frac{Wl}{4}=\frac{fLt^2}{6}$

Compiled by William F. Fischer

VI.—FORMULAS FOR STRENGTH OF FLAT PLATES.

Circular Flat Plates, Supported All Around The Edge, Loaded With a Total Load $W=PR^2\pi$, Uniformly Distributed Over The Unsupported Surface Area Of The Plate.

Author and Reference	Formula as Given by Author	Safe Load Per Unit of Surface Area $P=$	Radius of Plate to Supported Edge $R=$	Unit Stress in Extreme Fibers of Material $f=$	Thickness of Plate, Inches $t=$	Total Safe Load $=PR^2\pi=$ $W=$	Deflection at Center of Plate $Y=$
Reuleaux, Trautwines C. E. Pocket Book 1906, Page 493	$P=\frac{ft^2}{R^2}$	$\frac{ft^2}{R^2}$	$t\sqrt{\frac{f}{P}}$	$\frac{PR^2}{t^2}$	$R\sqrt{\frac{P}{f}}$		$\frac{5PR^4}{6Et^3}$
	$t=R\sqrt{\frac{P}{f}}$			$0.314\frac{W}{t^2}$	$0.56\sqrt{\frac{W}{f}}$	$3.142ft^2$	$0.265\frac{WR^2}{Et^3}$
Grashof, Kent's, M. E. Pocket Book 1903 Page 900	$P=\frac{6ft^2}{5R^2}$	$1.2\frac{ft^2}{R^2}$	$1.095t\sqrt{\frac{f}{P}}$	$0.833\frac{PR^2}{t^2}$	$0.913R\sqrt{\frac{P}{f}}$		$0.7\frac{PR^4}{Et^3}$
				$0.265\frac{W}{t^2}$	$0.515\sqrt{\frac{W}{f}}$	$3.77ft^2$	$0.223\frac{WR^2}{Et^3}$
Bach, Hütte Des Ingenieurs Taschenbuch	$f=\frac{CPR^2}{t^2}$	$1.15\frac{ft^2}{R^2}$	$1.07t\sqrt{\frac{f}{P}}$	$0.87\frac{PR^2}{t^2}$	$0.93R\sqrt{\frac{P}{f}}$		$0.7\frac{PR^4}{Et^3}$
	$C=0.87$			$0.277\frac{W}{t^2}$	$0.526\sqrt{\frac{W}{f}}$	$3.6ft^2$	$0.223\frac{WR^2}{Et^3}$
Johnson, The Material of Construction, 1897, Page 73	$t=R\sqrt{\frac{P}{f}}$	$\frac{ft^2}{R^2}$	$t\sqrt{\frac{f}{P}}$	$\frac{PR^2}{t^2}$	$R\sqrt{\frac{P}{f}}$		No case given
				$0.314\frac{W}{t^2}$	$0.56\sqrt{\frac{W}{f}}$	$3.142ft^2$	No case given

E = Coefficient of Elasticity. $\pi=3.1416$

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...pins to keep the latter from creeping out in case they should become loose.
...grooves & are cut in on either side to permit the escape of oil and air.
...through these centers on the outer sides of the webs, except-ing numbers 1 and 6, which do not need to be laid out.

ber entitled "Formulas for Strength of Flat Circular Plates"

VII.—FORMULAS FOR STRENGTH OF FLAT PLATES.

Circular Flat Plates Firmly Secured All Around The Edge, Loaded With a Total Load $W = PR^2\pi$, Uniformly Distributed Over The Unsupported Surface Of The Plate.

Author and Reference	Formula as Given by Author	Safe Load Per Unit of Surface Area $P=$	Radius of Plate to Supported Edge $R=$	Unit Stress in Extreme Fiber of Material $f=$	Thickness of Plate, Inches $t=$	Total Safe Load $= PR^2\pi = W=$	Deflection at Center of Plate $Y=$
Heuleaux, Trautwines C. E. Pocket Book, 1906 Page 493	$P=\frac{3}{2}f(\frac{t}{R})^2$	$1.5\frac{ft^2}{R^2}$	$1.225t\sqrt{\frac{f}{P}}$	$0.667\frac{PR^2}{t^2}$	$0.8165R\sqrt{\frac{P}{f}}$		$\frac{PR^4}{6Et^3}$
	$t=R\sqrt{\frac{2}{3}\frac{P}{f}}$			$0.2\frac{W}{t^2}$	$0.46\sqrt{\frac{W}{f}}$	$4.7ft^2$	$0.053\frac{WR^2}{Et^3}$
Grashof, Kent's M.E. Pocket Book, Page 283	$f=\frac{2PR^2}{3t^2}$	$1.5\frac{ft^2}{R^2}$	$1.225t\sqrt{\frac{f}{P}}$	$0.667\frac{PR^2}{t^2}$	$0.8165R\sqrt{\frac{P}{f}}$		$\frac{PR^4}{6Et^3}$
	$t=\sqrt{\frac{2R^2P}{3f}}$ $P=\frac{3ft^2}{2R^2}$			$0.2\frac{W}{t^2}$	$0.46\sqrt{\frac{W}{f}}$	$4.7ft^2$	$0.053\frac{WR^2}{Et^3}$
Johnson, The Materials of Construction, Page 73	$f=\frac{3PR^2}{4t^2}$	$1.34\frac{ft^2}{R^2}$	$1.154t\sqrt{\frac{f}{P}}$	$0.75\frac{PR^2}{t^2}$	$0.866R\sqrt{\frac{P}{f}}$		No Case Given
	$t=\frac{R}{2}\sqrt{\frac{3P}{f}}$			$0.239\frac{W}{t^2}$	$0.49\sqrt{\frac{W}{f}}$	$4.19ft^2$	No Case Given

E = Coefficient of Elasticity $\pi = 3.1416$

Compiled by William F. Fischer

VIII.—FORMULAS FOR STRENGTH OF FLAT PLATES

Flat Circular Plates Loaded With a Concentrated Load W Applied At a Circumference, The Radius Of Which Is r_0.

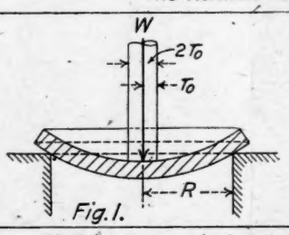

Fig. 1.

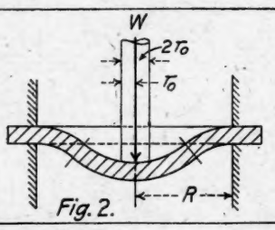

Fig. 2.

Plate Supported All Around The Edge, Fig. 1.

Author and Reference	Formula as Given by Author	Unit Stress in Extreme Fibers of Material, Lbs. per sq. Inch $f=$	Thickness of Plate in Inches $t=$	Safe Load $W=$	Deflection at Center of Plate, Inches $Y=$
Bach, Hutte, Des Ingenieurs Taschenbuch	$f=\frac{3C_1}{\pi}(1-\frac{2}{3}\frac{r_0}{R})\frac{W}{t^2}$ $C_1 = 1.5$	$1.433\frac{W(1-\frac{2}{3}\frac{r_0}{R})}{t^2}$	$1.2\sqrt{\frac{W(1-\frac{2}{3}\frac{r_0}{R})}{f}}$	$0.7\frac{ft^2}{(1-\frac{2}{3}\frac{r_0}{R})}$	$0.5\frac{WR^2}{Et^3}$
Grashof, Kent's M.E. Pocket Book, Page 284	$f=(\frac{4}{3}\text{Nat. Log.}\frac{R}{r_0}+1)\frac{W}{\pi t^2}$ $=\frac{CW}{\pi t^2}$ $C=(\frac{4}{3}\text{Nat. Log.}\frac{R}{r_0}+1)$	$\frac{CW}{\pi t^2}$	$\sqrt{\frac{CW}{\pi f}}$	$\frac{\pi t^2 f}{C}$	$0.53\frac{WR^2}{Et^3}$

See Table Below.

Table Giving Values of C. (Grashof)

$\frac{R}{r_0}=$	10	20	30	40	50	$C=(\frac{4}{3}\text{Nat. Log.}\frac{R}{r_0}+1)$
$C=$	4.07	5.00	5.53	5.92	6.22	

Plate Firmly Secured All Around The Edge, Fig. 2.

Grashof, Hutte, Des Ingenieurs Taschenbuch	$f=1.\frac{4}{3}\text{Nat. Log.}\frac{R}{r_0}\frac{W}{t^2}$	f $0.424\frac{W}{t^2}\text{Nat. Log.}\frac{R}{r_0}$	t $0.65\sqrt{\frac{W\,\text{Nat. Log}\frac{R}{r_0}}{f}}$	W $2.36\frac{ft^2}{\text{Nat. Log}\frac{R}{r_0}}$	Y $0.48\frac{WR^2}{Et^3}$

E = Coefficient of Elasticity. $\pi = 3.1416$

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	ection enter Plate Y=
	$\frac{PR^4}{Et^3}$
	$3\frac{WR^2}{Et^3}$
	$\frac{PR^4}{Et^3}$
	$3\frac{WR^2}{Et^3}$
	Case iven
	o Case Given